(12) UK Patent Application (19) GB (11) 2 327 897 (13) A

(43) Date of A Publication 10.02.1999

(21) Application No 9820190.8

(22) Date of Filing 24.09.1997

Date Lodged 16.09.1998

(30) Priority Data
(31) 08739511 (32) 28.10.1996 (33) US

(62) Divided from Application No 9720328.5 under Section 15(4) of the Patents Act 1977

(51) INT CL[6]
B07B 1/28 , B01D 33/03

(52) UK CL (Edition Q)
B2H H33BX H33B11 H33B15A H33B3X
U1S S2405

(56) Documents Cited
None

(58) Field of Search
UK CL (Edition P) B1D DNDX DNPA , B2H HX3 H33BX H33B11 H33B15A H33B3X H9
INT CL[6] B01D 33/03 35/22 , B07B 1/28 1/40 1/46
Online: WPI, Claims, Japio

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(54) Abstract Title
Vibrating screen system

(57) The system comprises a resiliently mounted housing 13, a vibratory drive coupled to the housing, a screen 82 extending across the housing and including a peripheral frame 84, a screen cloth 86 extending to and held by the frame and a discharge port 90 therethrough inwardly of the frame, a first discharge passage 44 fixed to the housing and extending from below the discharge port to outwardly of the housing, a cover 48 enclosing the housing above the screen, the cover having an access port 64 above the screen and aligned with the discharge port 90 and a discharge plug 102 selectively positioned to extend through the access port and close the discharge port. Also claimed is a system with a vacuum source extending into the housing above the screen and a bleed line extending into the housing below the screen and open to a source of dry gas at pressures higher than those of the vacuum source at the screen.

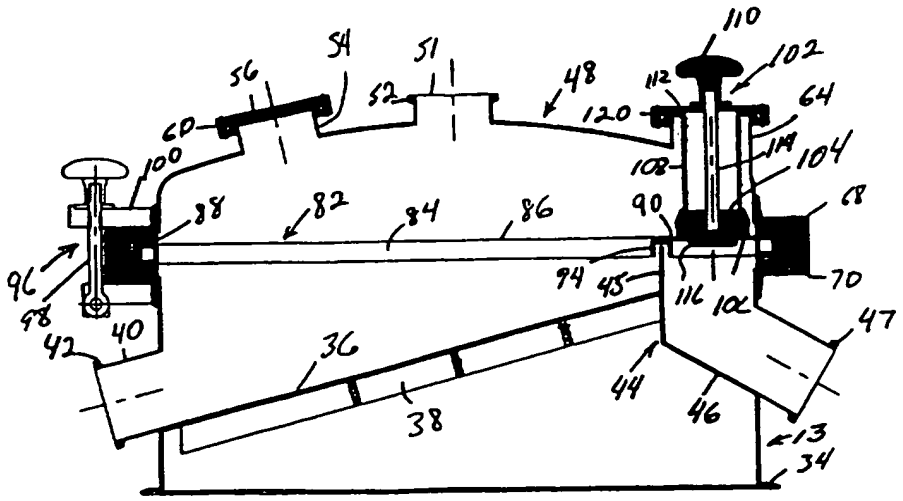

FIG. 2

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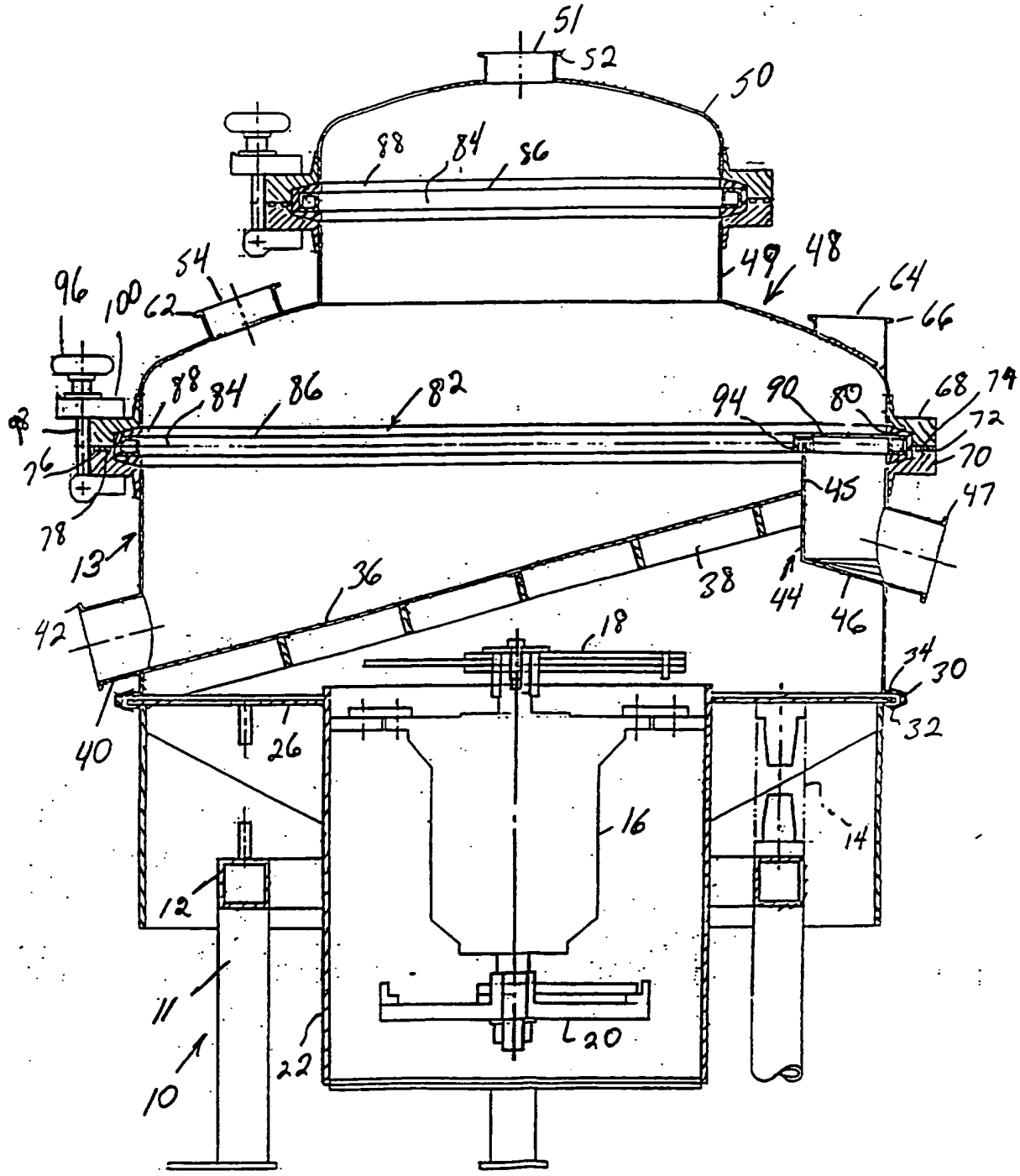
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FIG 1

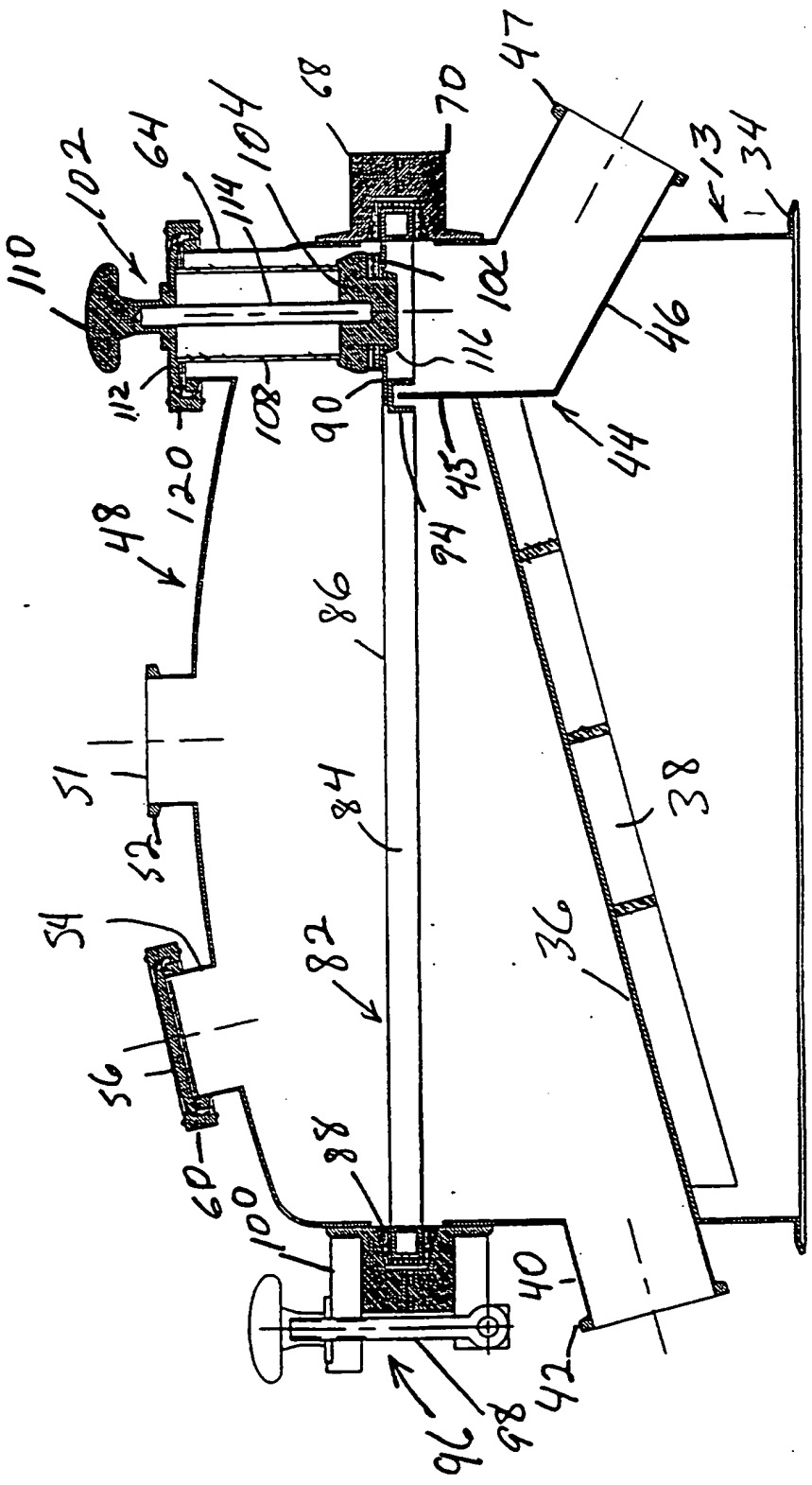
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FIG. 2

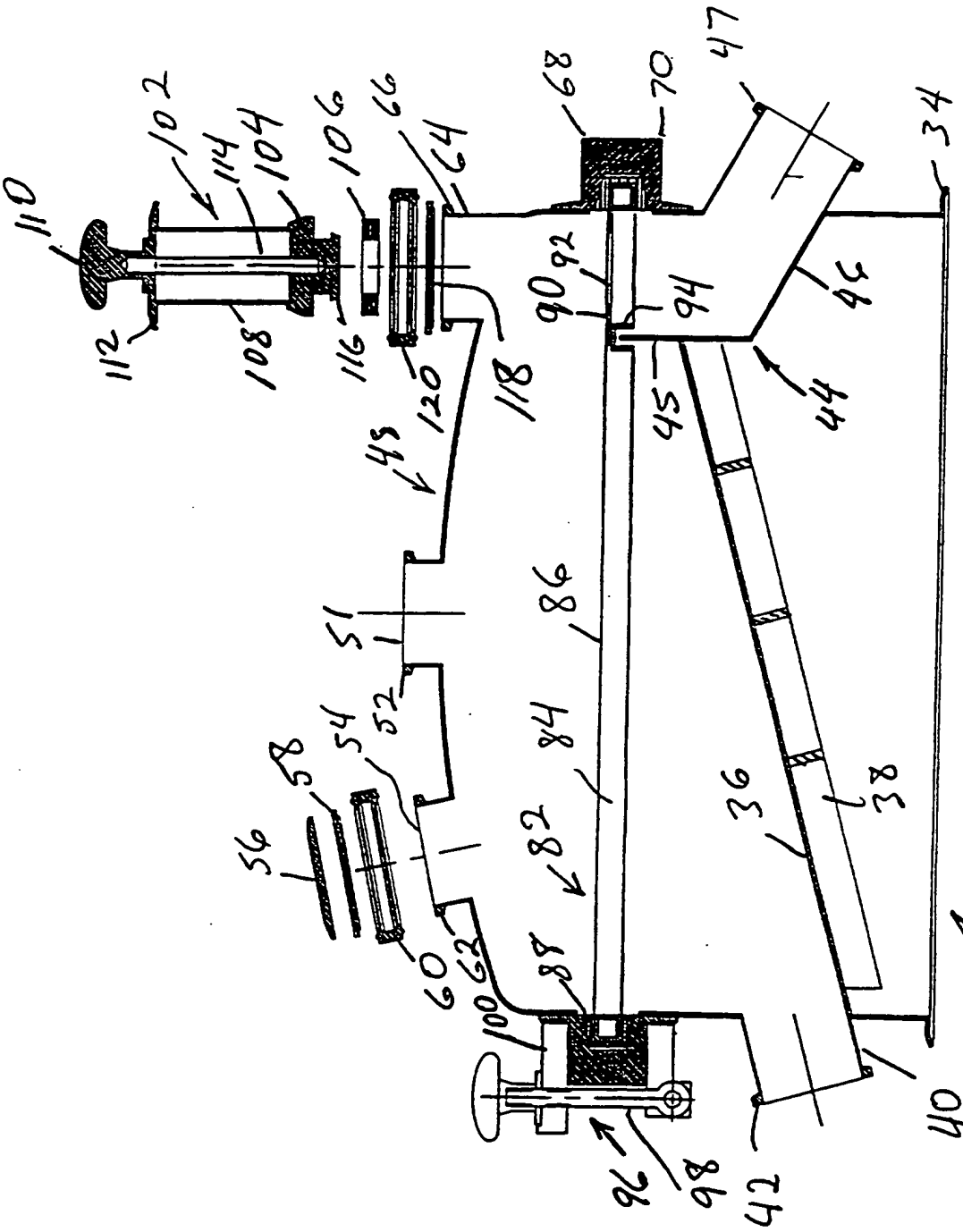
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FIG. 3

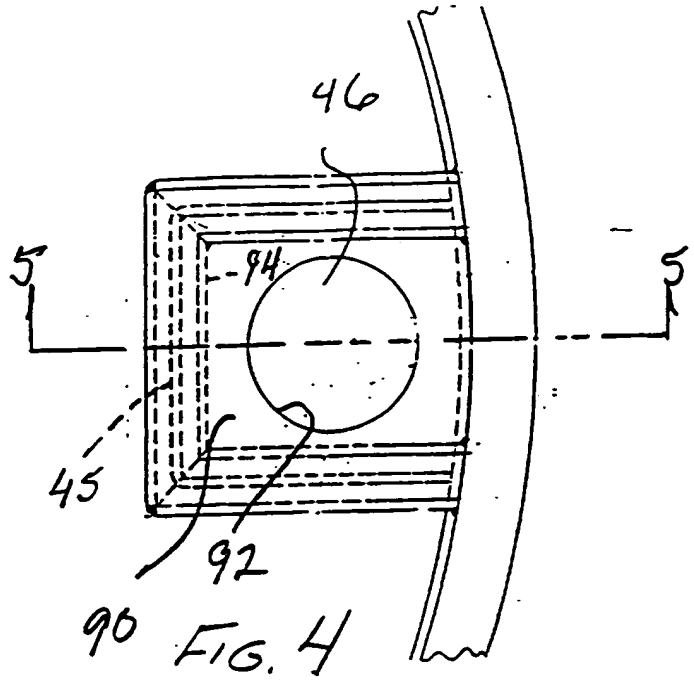

FIG. 4

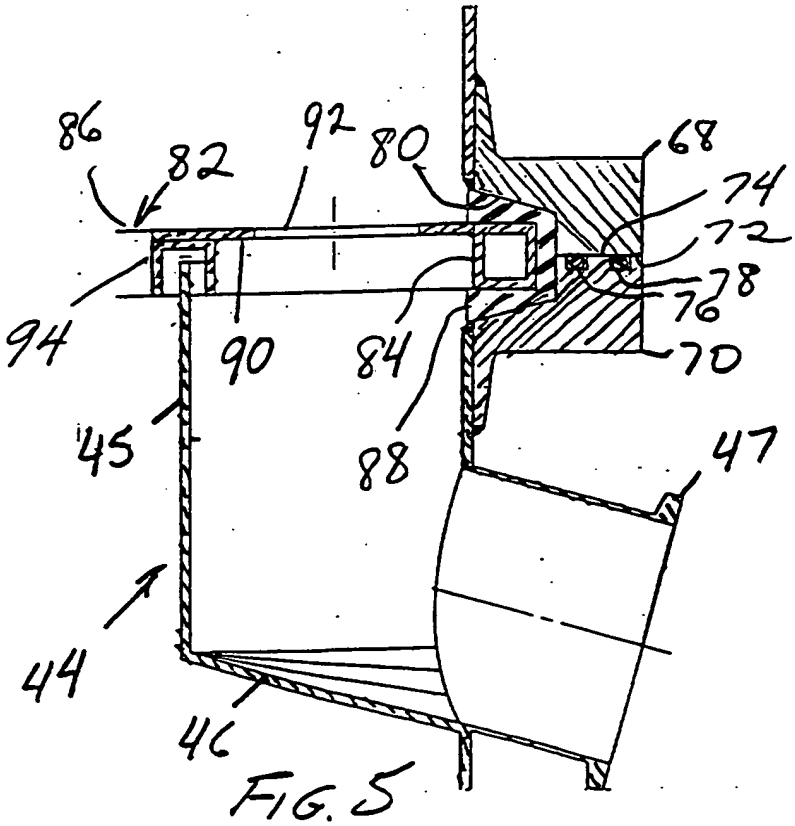

FIG. 5

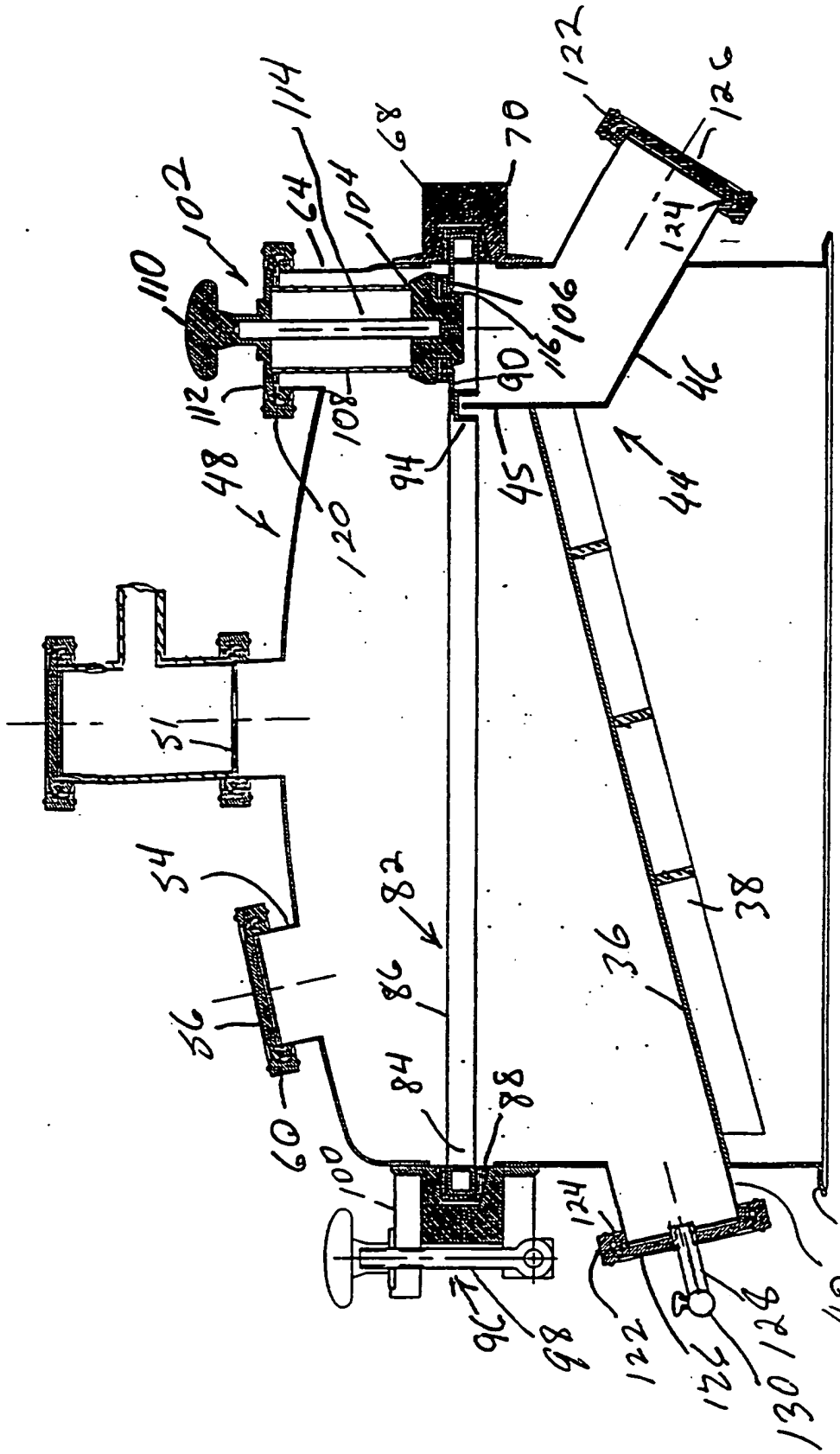
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FIG. 6

DESCRIPTION

SCREENING SYSTEM

BACKGROUND OF THE INVENTION

The field of the present invention is vibratory screening systems, including methods of use.

Vibratory screening using a resiliently mounted housing with one or more vibration generators attached thereto and a screen extending across the housing is well known. A great variety of motions, screen configurations and screen materials are available. Such systems are used for dry powder separation and sifting, wet screening and dewatering. Depending on the materials being processed, safety factors and environmental considerations, covers and hoods have also been used.

Recent patents disclosing such systems and components include U.S. Patent No. 4,613,432; U.S. Patent No. 4,810,-372; U.S. Patent No. 4,968,366; U.S. Patent No. 5,032,210; U.S. Patent No. 5,051,171; U.S. Patent No. 5,134,893; U.S. Patent No. 5,226,546; U.S. Patent No. 5,242,058; U.S. Patent No. 5,255,789; U.S. Patent No. 5,265,730; U. S. Patent No. 5,271,504; and U.S. Patent No. 5,456,365, the disclosures of which are incorporated herein by reference.

The demands upon equipment for handling and processing materials are quite stringent in certain highly technical areas. Clean room manufacturing and material handling frequently require rigid controls against contamination, inert surfaces and the ability to completely clean systems

between uses. At the same time, stringent requirements on processing effectiveness remain.

SUMMARY OF THE INVENTION

The present invention is directed to a screening system including mechanisms and methods of use having particular applicability to clean room environments.

A first, separate aspect of the present invention consists of:

a resiliently mounted housing;

a vibratory drive coupled to the housing;

a screen extending across the housing and including a peripheral frame and screen cloth extending to and held by the peripheral frame;

a cover enclosing the housing above the screen, the cover including an inlet port above the screen;

a vacuum source extending into the housing above the screen;

a bleed line extending into the housing below the screen and open to a source of dry gas at pressures higher than those of the vacuum source at the screen.

In a second, separate aspect of the present invention, a vibratory screen separator includes a screen extending across a housing with a cover. The cover includes an

access port and the screen includes a discharge port aligned with the access port. A discharge plug is selectively positionable to extend into the access port to close the discharge port. This arrangement provides for extended residence time for material being processed and direct downward discharge.

In a third, separate aspect of the present invention, a vibratory screen separator includes a discharge port

through the screen. A exit conduit is in communication with the port and extends to outwardly of the housing. The port and conduit form a discharge passage coupled together by a labyrinth seal. A downwardly facing channel receives the upper extent of the conduit to prevent flow through the screen into the conduit. A downward flow from the screen is possible with this arrangement without crossing crevasses and seams. Easy and repeatable screen assembly with the separator is also possible.

In a fourth, separate aspect of the present invention, the housing and the cover of a vibratory screen separator each include a flange about the periphery at the edge of each element in order that the elements might be brought together and clamped. The flanges define an inwardly facing channel which is capable of receiving a U-shape gasket for receipt of a screen frame. The gasket is such that screen cloth on the screen frame extends to under the gasket so that there are no crevasses, cavities or depressions outwardly of the screen cloth which would be accessible to the material being processed. The flanges may also include sealing therebetween for closure of the unit during cleaning and the like even when a screen is not present.

A fifth, separate aspect of the present invention consisting of a screening process using a resiliently mounted housing with a vibratory drive coupled to the housing and a screen extending across the housing and including a peripheral frame and screen cloth extending to and held by the peripheral frame for drying material, comprising

depositing the material on the screen;

vibrating the screen at a first vibrational energy level to deliquefy the material with the liquid passing through the screen for discharge;

vibrating the screen with a second, reduced vibrational energy level after vibrating the screen at the first level;

drawing a vacuum above the screen while vibrating the screen at the second vibrational energy level;

bleeding dry gas to below the screen at pressures higher than those exerted by the vacuum to allow upward flow of dry gas through the material on the screen while drawing the vacuum.

In a sixth, separate aspect of the present invention, the method of the fifth, separate aspect of the present invention is further contemplated to include appropriate plugging and unplugging of the discharge passage to regulate residence time and controlling discharge.

In a seventh, separate aspect of the present invention, combinations of the foregoing aspects are contemplated.

Accordingly, it is an object of the present invention to provide improved screening systems and the use thereof. Other and further objects and advantages will appear hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional side view of a separator

Figure 2 is a cross-sectional side view of the housing and cover of a separator.

Figure 3 is a cross-sectional side view of the housing and cover of Figure 2 shown in partially exploded assembly.

Figure 4 is a plan detail of the discharge port.

Figure 5 is a cross-sectional detail taken along the line 5-5 of Figure 4.

Figure 6 is a cross-sectional side view of the housing and cover of Figure 2 in a vacuum mode.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning in detail to the drawings, a vibratory screen separator is illustrated which includes a base 10 for supporting the entire system. The base 10 in this embodiment includes three legs 11 with a circular frame 12 to raise the system to a convenient height. A housing, generally designated 13, is resiliently mounted to the base 10 by means of springs 14. In this embodiment, the housing 13 is cylindrical. The resiliently-mounted housing 13 is driven to vibrate by a vibratory drive including a motor 16 to which are attached eccentric weights 18, 20 preferably mounted to the motor shaft at the top and bottom. The bottom eccentric weights 20 may be of a type which can be varied manually or be varied automatically depending upon the direction of motor rotation.

The vibratory drive is enclosed in a stainless steel drive housing 22. The drive housing 22 is substantially sealed. It may have a vacuum outlet and an air inlet for ventilation and cooling. Vacuum is typically available in clean rooms and the environment is typically maintained as dry air. Appropriate equipment can be provided as needed to supply these needs. An air tight window access is associated with the drive housing 22 to facilitate adjustment and service. The drive housing is shown to be associated with the housing 13 and will, therefore, vibrate with the housing 13.

The vibratory drive is associated with the underside of the housing 13 which includes a structural plate 26 with gussets 28. The motor 16 is fixed to the drive housing 22 which is in turn fixed to the structural plate 26. The plate 26 is associated with the rest of the housing 13 by a conventional band clamp 30 and gasket 32. A flange 34 at the lower end of the housing 13 is associated with the band clamp 30.

A plate is welded to the interior of the housing 13 at a slope to create a manifold 36 for receiving flow through the screen deck. Support plates 38 stiffen the manifold 36. A discharge passage 40 extends from the manifold 36 to outwardly of the housing 13. This discharge passage 40 is also welded or otherwise formed to be a solid part of the housing 13. The passage 40 extends to a mounting flange 42 to accommodate a closure assembly or camp band.

Also within the housing 13 is a discharge passage 44 which extends downwardly from the screen deck and then outwardly through the wall of the housing 13. This discharge passage 44 includes a weldment substantially rectangular in cross section using the outer wall of the housing 13 to define a down chute 45 from an upper edge just below the screen deck. A lower surface 46 closes the chute 45 and terminates in the tube through the wall of the housing 13. A flange 47 is provided for attachment. The entire housing assembly with the manifold 36 and the discharge passages is typically an assembled weldment.

A main cover, generally designated 48, is shown positioned to close the upper portion of the housing 13. The main cover 48 includes sides configured to align with the sides of the housing 13 which is, in this case, cylindrical.

In the embodiment of Figure 1, the main cover 48 includes an upper screen deck. The central portion of the main cover 48 includes a cylindrical housing 49 extending upwardly to an upper cover 50. A screen deck is provided which has much the same features as the lower screen deck which is described below and reference is made thereto. This screen may be used to break up caked material and the like.

Three ports are shown through the cover or covers. In the embodiment of Figure 1, two ports are shown through the main cover 48 and the other through the upper cover 50. In the embodiment of Figure 2 and following, the

ports are all through the main cover 48. Each port is preferably less than 10% of the overall area of the cover so as to avoid structural problems under vacuum. An inlet port 51 is conveniently located along the vertical centerline of the unit. This inlet port 51 also includes a flange 52 for coupling with delivery equipment. An observation port 54 is provided off center on the cover 48. It is similarly constructed to that of the inlet port 51 and preferably includes a sight glass 56, a gasket 58 and a closure or clamp assembly 60 cooperating with the flange 62. Finally, an access port 64 is similarly constructed and positioned adjacent to the peripheral edge of the cover 48. The access port 64 includes a flange 66 for attachment.

To assemble the cover 48 with the housing 13 in both embodiments, peripheral flanges 68 and 70 are fixed to the lower edge of the cover 48 and the upper edge of the housing 13, respectively. The flanges 68 and 70 are typically welded to the structures. The joint between the flanges 68 and 70 and their respective cover 48 and housing 13 are preferably tight so that there is no leakage with the structure subjected to vacuum. The peripheral flanges 68 and 70 have opposed mating surfaces 72 and 74. In the surface 74, channels are cut to receive two EPDM O-rings 76 and 78 which extend fully about the structure. EPDM is the common name for pharmaceutical grade elastomer made of ethylene propylene diene monomer which is substantially inert to most solvents and unreac-

tive with pharmaceutical compounds. The O-rings compress against the surface 72 to seal the structure independently of any seal associated with a screen structure. The peripheral flanges 68 and 70 also each contain a profile generating an inwardly facing channel 80. The walls of the channel 80 have draft so that the channel 80 is wider at the opening than at the base.

A screen, generally designated 82, includes a frame 84 and screen cloth 86. The frame 84 and screen cloth 86 are most conventionally stainless steel with the screen cloth 86 tensioned and bonded to the frame 84. In the preferred embodiment, the housing 13 and cover 48 are circular. The screen frame 84 is also circular for that reason. The frame 84 is conveniently substantially square in cross section and is shown in this embodiment to be larger than the principal diameter of the housing 13. In this way, the screen 82 may be positioned with the frame 84 extending well into the inwardly facing channel 80.

An EPDM screen gasket 88 of U-shape cross section is positioned about the screen frame 84 and compressed within the inwardly-facing channel 80 defined by the peripheral flanges 68 and 70. The gasket 88 extends over the bonding area between the screen cloth 86 and the screen frame 84 so that no cracks, joints and recessed areas are available within the interior of the housing 13 at the screen for processing material to collect. The upper screen deck of Figure 1 is similarly constructed, as is the screen to this point in the description. The lower screen 82

includes a plate 90 which is bonded to the under side of the screen cloth 86. A discharge port defined by a hole 92 is central to the plate 90. The screen cloth 86 does not extend over the hole 92. The plate 90 is positioned below the screen cloth in order that material is unimpeded in its movement to the hole 92. The plate 92 has a channel 94 extending downwardly from three edges. This channel 94 is also welded to the frame 84. The hole 92 is conveniently located adjacent to the periphery but may be located at any desired position on the screen.

The hole 92 in the screen 82 defines a discharge port for the materials unable to pass through the screen. The discharge passage 44 extends from this discharge port to outwardly of the housing 13. With the screen properly indexed in the housing 13, the channel 94 fits over the upper end of the structural portion of the discharge passage 44 which is fixed to the side of the housing 13. A labyrinth seal is thus created to prevent water from flowing into the discharge passage. Consequently, material remaining on the screen 82 can flow to the hole 92 and from that upper end of the discharge passage pass outwardly of the housing 13. With the hole 92 plugged, only flow of fines and moisture can pass through the screen 82. Because of the channel 94, water flowing through the screen cannot flow into the discharge passage associated with the hole 92.

A first clamp 96 is illustrated for assembling the housing 13 and the cover 48. Two such clamps are believed

to be sufficient for this purpose. Four are contemplated. More clamps can be added as necessary. The clamps 96 each conveniently employs a swing bolt 98 received in a slot defined by an upper bar 100. The clamps 96 provide sufficient strength and the flanges 68, 70 sufficient rigidity to maintain the seal between the housing 13 and the cover 48 under vibration and with the gasket 88 compressed around the screen frame 84.

A discharge plug 102 is positionable through the access port 64 to close the hole 92. With the cover 48 properly indexed, the access port 64 is aligned with the hole 92 and is larger than the hole 92 so that the discharge plug 102 may pass through the access port and into engagement with the plate 90. The discharge plug 102 includes a plug element 104 receiving an EPDM gasket 106. The body of the plug 102 is defined by a cylindrical spacer 108. At the upper end of the plug 102, a handle 110 includes a flange 112. A threaded rod 114 retains the assembly together. A conical end on the plug element 104 assists in the location of the discharge plug 102 into the hole 92.

Placement of the discharge plug 102 in the structure locates the conical end 116 in the hole 92. The EPDM gasket 106 comes to rest on top of the screen about the hole 92 to form a seal. An EPDM gasket 118 is positioned atop the access port 64 and receives the flange 112. A clamp assembly 120 is used to retain the flange 112 with the flange 66 with the gasket 118 therebetween.

In operation, a screen 82 is positioned within the housing 13. A cover 48 is then positioned on the housing 13 with the access port 64 aligned with the hole 92 in the screen 82. The discharge plug 102 is positioned to close the hole 92 and all elements are clamped together. The screen is vibrated using the vibratory drive and the material is fed into the inlet port 51. In the event that the material is to be dewatered, the separator is run until substantially all of the free water or other liquid flows through the screen and is discharged to the manifold 36 and through the discharge passage 40. The vibratory motion of the separator can be adjusted according to conventional techniques to cause the material on the screen to tend toward the center of the screen. Once sufficiently dewatered, the discharge passages 40 and 44 are closed. Closure is accomplished in each case by a clamp assembly 122 associated with an EPDM gasket 124 and a cap plate 126 effectively acting as valves. A bleed line extends into the housing below the screen. In this instance, a bleed line 128 is associated with the cap plate 126 which is placed on the discharge passage 40. A valve 130 may be provided on the bleed line 128 to regulate flow. A vacuum is drawn on the inlet port 51. The bleed line is adjusted or configured to provide substantially more resistance to gas flow than the vacuum source. Consequently, a vacuum can be drawn on the separator even with the bleed line 128 open. In clean room environments, the bleed line may draw directly from the dry atmosphere

around the separator. Alternatively, special provision may be employed to insure dry, clean air is drawn into the separator.

During the vacuum phase of the drawing process, the vibrational energy created by the vibratory drive is reduced. This reduction is intended to reduce the distribution of the drying material onto the surfaces of the separator other than the screen 82. The vacuum operates to increase the efficiency of evaporation. Further, bleeding air in below the screen 82 with vibration of the screen 82 causes flow up through the screen to separate the material from the screen 82, break up caking and unblind the screen.

Once the material is sufficiently dried, the discharge plug 102 may be withdrawn. The vibratory motion is preferably increased and altered in character such that the material on the screen will move to the outer periphery where it can pass through the hole 92. The operation of vibration throughout assists in avoiding the material from forming into a cake as it is dried.

The uses of this screening system contemplates batch processes and frequent cleaning. Cleaning is achieved by removing the screen and clamping conventional cleaning heads onto the several ports in the housing and cover. Such heads provide spray nozzles or steam nozzles to completely wash the interior of the system. The screen 82 would be separately washed, also in a conventional manner.

Accordingly, an improved screening system and method of using that system are disclosed.

What is claimed is:

1. A screening system comprising

a resiliently mounted housing;

a vibratory drive coupled to the housing;

a screen extending across the housing and including a peripheral frame, screen cloth extending to and held by the peripheral frame and a discharge port therethrough inwardly of the peripheral frame;

a first discharge passage fixed to the housing, and extending from below the discharge port in the screen to outwardly of the housing;

a cover enclosing the housing above the screen, the cover including an access port above the screen and aligned with the discharge port;

a discharge plug selectively positionable to extend through the access port and close the discharge port.

2. The screening system of claim 1, the discharge plug closing the access port with the discharge port closed by the discharge plug.

3. The screening system of claim 1 further comprising

a first peripheral flange fixed to the upper edge of the housing;

a second peripheral flange fixed to the lower edge of the cover, the first and second peripheral flanges

mating together and defining an inwardly facing channel therebetween, the peripheral frame of the screen extending into the channel;

a U-shape gasket between the peripheral frame and the channel, the screen cloth extending on the peripheral frame to within the gasket.

4. A screening system comprising

a resiliently mounted housing;

a vibratory drive coupled to the housing;

a screen extending across the housing and including a peripheral frame and screen cloth extending to and held by the peripheral frame;

a cover enclosing the housing above the screen, the cover including an inlet port above the screen;

a vacuum source extending into the housing above the screen;

a bleed line extending into the housing below the screen and open to a source of dry gas at pressures higher than those of the vacuum source at the screen.

5. The screening system of claim 4 further comprising

a manifold extending across and fixed to the housing below the screen;

a first discharge passage extending from the manifold to outwardly of the housing;

a first valve selectively closing the first discharge passage;

a second discharge passage fixed to the housing and extending from the screen to outwardly of the housing, the screen having a discharge port therethrough, the second discharge passage extending from the discharge port;

a second valve selectively closing the second discharge passage.

6. The screening system of claim 4 further comprising

a first discharge passage fixed to the housing, the screen including a discharge port therethrough inwardly of the peripheral frame, the first discharge passage extending from below the discharge port in the screen to outwardly of the housing.

7. The screening system of claim 6 further comprising

a discharge plug selectively positionable to close the discharge port.

8. The screening system of claim 7, the cover including an access port above the screen and aligned with the discharge port, the discharge plug closing the access port with the discharge port closed by the discharge plug.

9. The screening system of claim 4 further comprising

a first discharge passage fixed to the housing, the screen including a discharge port therethrough inwardly of the peripheral frame and a support frame fixed to the peripheral frame about the discharge port, the screen cloth being fixed to the support frame, the support frame having a downwardly facing channel, the first discharge passage having an upper edge within the channel, the first discharge passage extending from the upper edge to outwardly of the housing.

10. The screening system of claim 4 further comprising

a first peripheral flange fixed to the upper edge of the housing;

a second peripheral flange fixed to the lower edge of the cover, the first and second peripheral flanges mating together and defining an inwardly facing channel therebetween, the peripheral frame of the screen extending into the channel;

a U-shape gasket between the peripheral frame and the channel, the screen cloth extending on the peripheral frame to within the gasket.

11. A screening process using a resiliently mounted housing with a vibratory drive coupled to the housing and a screen extending across the housing and including a peripheral frame and screen cloth extending to and held by the peripheral frame for drying material,

comprising

depositing the material on the screen;

vibrating the screen at a first vibrational energy level to deliquefy the material with the liquid passing through the screen for discharge;

vibrating the screen with a second, reduced vibrational energy level after vibrating the screen at the first level;

drawing a vacuum above the screen while vibrating the screen at the second vibrational energy-level;

bleeding dry gas to below the screen at pressures higher than those exerted by the vacuum to allow upward flow of dry gas through the material on the screen while drawing the vacuum.

12. A screening system using a resiliently mounted housing with a vibratory drive coupled to the housing and a screen extending across the housing and including a peripheral frame and screen cloth extending to and held by the peripheral frame, the housing having a discharge passage extending through the screen to out of the housing for drying material, comprising

plugging the discharge passage;

vibrating the screen to deliquefy the material with the liquid passing through the screen for discharge

depositing the material on the screen after plugging the discharge passage;

drawing a vacuum above the screen while vibrating the screen;

bleeding dry gas to below the screen at pressures higher than those exerted by the vacuum to allow upward flow of dry gas through the material on the screen while drawing the vacuum

unplugging the discharge passage after drawing the vacuum.

13. The screening process of claim 12, the steps being in seriatim.

14. The screening process of claim 12, the step of vibrating the screen including vibrating the screen at a first vibrational energy level, vibrating the screen at a second, reduced vibrational energy level after vibrating the screen at the first level, vibrating the screen at a third vibrational energy level increased over the second, reduced vibrational energy level after unplugging the discharge passage, the step of drawing a vacuum being while vibrating the screen at the second, reduced vibrational energy level.

15. The screening process of claim 14, the step of vibrating the screen at the first vibrational energy level being with motion concentrating the material toward the center of the screen, the step of vibrating the screen at

the third vibrational energy level being with motion concentrating the material toward the periphery of the screen, the discharge passage being displaced from the center of the screen.

16. A screening system substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

INVESTOR IN PEOPLE

Application No: GB 9820190.8 **Examiner:** Michael R. Wendt
Claims searched: 1 - 3 **Date of search:** 7 December 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): B2H (H33B, HX3, H9); B1D (DNPA, DNDX)

Int Cl (Ed.6): B07B 1/28, 1/40, 1/46; B01D 33/03, 35/22

Other: WPI, Claims, Japio

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
	NOTHING OF RELEVANCE FOUND	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.